over, that it is necessary to take into account the absorption, and therefore his formula contains an exponential term to allow for this.

A perhaps still more important discovery mentioned in the paper is that of Dr. Louis Cohen, that if the reduction in the strength of the received current due to absorption be written e^{-Ad}, then A is inversely proportional to the square root of the wave-length within the limits of accuracy of the experiments.

Mr. Austin again checks Mr. Marconi's statement that the received signals are proportional to the height of the two antennæ, and adding to this the observation that they also vary inversely as the wave-length, he obtains a complete formula giving the received current I_R in terms of the transmitted current I_S, the heights of the two antennæ $h_1 h_2$, the wave-length λ, and the distance d. The formula is

$$I_R = 4 \cdot 25 \frac{I_S h_1 h_2}{\lambda d} e^{-\frac{0 \cdot 0015 d}{\sqrt{\lambda}}}.$$

Where the currents are in amperes and the lengths in kilometres, the two constants 4·25 and 0·0015 may depend on the conditions under which the experiments were made, and it will be of great interest if other wireless workers will check the formula against their results and see how closely it is applicable. It must not be expected that this formula will be closely confirmed by every observation. Mr. Austin's own observations show that this is not the case. In spite of the wide range of values he has dealt with, the observations do appear to group themselves round the smooth curves given by his formula.

The formula refers only to flat-topped aërials and to general day conditions. Mr. Austin remarks that the night signals are entirely irregular, being, in general, stronger than the day signals, and this he assumes is due to there being much less absorption at night, that is to say, the inverse distance law is then more nearly obeyed, even for very long distances.

It is perhaps of interest to compare Mr. Austin's formula with the measurements in the *Monarch* tests. Putting the data into Mr. Austin's formula, and taking the wave-length at 250 metres, which was approximately the case, the received current at a distance of 60 miles given by the formula is 590 microamperes, whereas it was actually only about 50 microamperes. It is evident, therefore, that the constant 4·25 is too large for this case. One reason for this may be the great difference in the type of aërial used, Mr. Austin's formula applying to a flat-topped aërial, whereas a straight aërial was used for the Holyhead-Howth experiments; another reason, the Howth aërial had a higher resistance.

The absorption coefficient, however, seems to fall in very well with the *Monarch* experiments, neglecting the short distances, which are irregular. Taking the slope of the curves for the *Monarch* crossing from Howth to Holyhead, the absorption is rather less than that given by Mr. Austin, but the slope of the curve for the *Monarch* returning from Holyhead to Howth indicates a slightly greater absorption.

A number of tables are given in the paper to facilitate the use of the formula in practice. These tables show how extremely important it is to use a long wave-length for long distances; for instance, for transmission over a distance of 2000 miles, with a wave-length of 1000 metres and two flat-topped aërials 450 feet high, 490 amperes is required in the transmitter, whereas at 6000 metres only 105 amperes is necessary. There are still, however, many obscure points in the long-distance transmission which Mr. Austin's formula does not account for; for instance, Mr. Marconi pointed out at the Royal Institution a short time back that there were two minima near sunset and sunrise in the curve representing the strength of the received signals across the Atlantic, and also two maxima. Can this be accounted for purely by variation in the absorption coefficient, and, if so, does the absorption coefficient during the minima bear the same relationship to the wave-length as that given in Mr. Austin's formula? Do the two maxima correspond to practically no absorption, or are they higher values than would be obtained if no absorption existed as if waves were concentrated, as Mr. Austin seems to consider possible?

Whether the formula turns out to be strictly right or not, it should form a good basis on which to compare different wireless systems, and it constitutes a real advance in the published knowledge of long-distance radio-telegraphy.

W. DUDDELL.

EXPERIMENTS ON AERIAL PROPELLERS.[1]

AN article in the April *Bulletin de la Société d'Encouragement* deals with some experiments on aërial propellers made by MM. Legrand and Gaudart, with the aid of a grant from the society. The greater part of the article is a discussion on the methods adopted by other experimenters for expressing their results. M. Legrand objects to the three coefficients usually adopted in expressing the results of propeller experiments, namely, "pitch," "fraction of pitch in each blade," and "percentage slip." He objects to the use of "constructional pitch" (which is usually taken as the pitch of the pressure face chords), as it is not constant for all parts of the blade in modern propellers. He also objects to the use of the pitch corresponding to no thrust, as this is not constant for all speeds; but in our opinion this latter is constant enough for all practical purposes.

M. Legrand's objection to the use of the coefficient "fraction of pitch in each blade" is that it is not definite for a given propeller; as, in modern propellers, it is not the same for all co-axial, cylindrical sections of the blades. This objection, however, is entirely overcome by using "disc area ratio," which is equivalent to "fraction of pitch," and is also absolutely definite for any given propeller. The objection advanced against the use of "percentage slip" is that the pitch not being definite, or the same for all parts of the blade, the slip is also indefinite.

Efficiency curves by Géber and Dorand are quoted, in which efficiencies at constant rotational speeds are plotted against translational speed. If, however, efficiencies at constant rotational speeds are plotted against percentage slip, and the pitch used in the reduction of the experimental results be stated—the percentage slip being equal to 100 $\left(\frac{\text{pitch} \times \text{revs.} - \text{translational speed}}{\text{pitch} \times \text{revs.}}\right)$—it is readily seen that the two sets of curves are equivalent and derivable from each other. Also, plotting against percentage slip has the advantage that it brings all the efficiency curves close together.

It is generally admitted that the indefiniteness of the pitch of a propeller is a disadvantage; but it seems, as yet, to be the best "coefficient" that can be used to give a general idea of the type of a given propeller. M. Legrand does not give any substitute for "pitch," and, in connection with his own experiments, differentiates between a propeller with a big pitch and one with a small pitch.

The experiments were carried out on full-size propellers, mounted on actual aëroplanes and driven by a 50 h.p. Gnome engine. The thrust was registered during the whole flight on an autographic diagram from a Richards dynamometer, working in conjunction with a flexible mounting for the propeller. An error is admitted of at least 2 per cent. of the maximum thrust in the calibration of the dynamometer. The rotational speed of the propeller was measured by means of a direct reading tachometer, and is probably correct to about 1 per cent. But the power absorbed was measured by assuming that the brake h.p. of the Gnome engine, at a given speed, did not vary during the course of a series of experiments. By this method of measuring, we should estimate the probable error on the measurement of power to be anything up to 10 per cent. The speed of translation of the machine was measured by means of an ordinary U tube, measuring the air pressure in a converging cone. This was calibrated by flying round a measured aërodrome, taking the speed with a watch. So that, taking into account the difficulty of flying exactly over the course and of reading a water-gauge on a vibrating aëroplane, the translational speed is probably not correct to closer than 3 per cent.

[1] "Études expérimentales sur les hélices propulsives Aériennes." By M. Legrand (Bulletin de la Société d'Encouragement pour l'Industrie Nationale, April).

The results given are very meagre, and are as follows:—The efficiencies varied between 53 per cent. and 69 per cent. The thrust fell off in flight about 33 per cent. from the value with the aëroplane anchored. The rotational speed of the engine increased in flight from 0 per cent. to 15 per cent. above the speed with the aëroplane anchored, depending on the propeller. The experiments are to be continued with the aid of a further grant, and we may therefore expect more complete results of tests with the addition of more particulars of the propellers tested than are given in the present article.

It is to be hoped that the experimenters may improve the accuracy of their apparatus, so that their results may be of real scientific value, and not merely for the purpose of differentiating between a good propeller and a bad one.

FRANCIS H. BRAMWELL.

PHOTOGRAPHY IN SURVEYING.

FOR the last half a century continued efforts have been made to utilise photography in the preparation of accurate plans of country, and thereby economise some of the time expended in the detailed measurement of every feature and object. A photographic negative provides an accurate record of the area included in it, contains much detail which measurement alone cannot give, and is always available for future reference. On the other hand, the employment of photography requires certain technical knowledge, and a good judgment in the selection of stations and views; it is best suited to regions of considerable relief, but even then patches of ground are liable to be omitted altogether from the views, and such omissions are not recognised until the work is plotted; lastly, it necessitates considerable skill in the drawing office to get the best and most complete results from the field-work. Photogrammetry has, therefore, developed most rapidly in countries where mountainous districts offer favourable conditions for its employment, and where the season available for field-work is limited. France, Italy, Germany, Austria, Switzerland, and Canada have all made use of this method in topographical surveys, despite its drawbacks. Mr. A. O. Wheeler[1] describes in general terms the methods which are employed in Canada under the direction of Dr. Deville, the Surveyor-General of Dominion Lands, and employed by Mr. Wheeler on Dr. Longstaff's recent expedition in British Columbia. But the labour involved in utilising the information collected by the camera has always hindered its wider employment in surveying, so that we welcome a new method of automatically reproducing it on a plane surface, which is described by Prof. E. Brückner.[2]

Some years ago Dr. C. Pulfrich, of the firm of Carl Zeiss, of Jena, produced his stereomicrometer, by which the coordinates of points represented on a pair of stereographic plates were determined, and their positions defined, so that they could be plotted on a plan. In this instrument the plates are fixed, and the movements of the index pointers are measured. A further development was the stereocomparator, in which the plates are movable, and the points to be measured are brought under fixed marks, in this case the objectives of a stereoscope. By suitable mechanical arrangements the coordinates of any point on the picture and the stereoscopic parallax are readily determined, thus providing the necessary information for plotting the point measured. Lieut. von Orel, of the Military Geographical Institute in Vienna, conceived the idea of automatically recording the data thus measured, and the necessary modifications have been made to the stereocomparator so as to enable the data to be plotted mechanically on a sheet of paper. This instrument is called the stereoautograph, and in it the movements of the plates and the stereoscope of the stereocomparator are communicated to flat rulers resting on the drawing-board, and by their aid the positions of points are plotted on the plan. Not only is the horizontal projection of the detail effected in this way, but contour lines representing the relief can also be drawn.

Plans on a scale of 1:25,000 can be accurately produced in this way, and even one on the scale of 1:10,000 showed but slight differences from a precise measured survey of the same on this scale. The apparatus is said to be capable of producing a map sheet 35 cm. by 25 cm. of a mountainous region to the scale of 1:25,000 in about ten days' work, so that it promises to be of great value in reproducing the work of travellers and explorers who will take the necessary photographs. Photogrammetric methods do not apply where surveying is organised so as to utilise a *personnel* of moderate technical ability, where each individual carries out a single stage of the work only; but where skilled technical assistance is available, and each surveyor executes as complete a survey as possible of a given area, then stereophotogrammetry, simplified by Lieut. von Orel's instrument, seems to offer great possibilities, especially when conditions of work and of surface relief are also favourable.

Though primarily adapted to topographical representation, some have tried to adapt photography to large-scale (cadastral) work, and M. J. Gaultier has proposed methods for its employment. But the indoor work of the necessary precision is tedious and costly, so that in a recent paper[1] he proposes for such work an instrument which he names the "topometrographe." This is of the nature of a plane table for precise work, stoutly built and carefully levelled, on which a base-bar is clamped. This carries the pivots of two rulers set at a distance apart corresponding to the base line used. These rulers are set at any desired angle with the base-bar by means of divided circles, and their intersection locates the apex of the triangle. Very considerable accuracy is claimed for the method, which is to be based on a network of third- or fourth-order triangulation; but its effectiveness would appear to be restricted to special cases, where such elaboration in the field is compensated for by economy in the office.

[1] *Geographical Journal*, June.
[2] *Mitt. d.k.k. geographischen Gesellschaft in Wien*, Bd. 54, No. 4.

[1] *Revue Scientifique*, May 6.

BIRD-NOTES.

FROM the point of view of forest-conservation much interest attaches to Mr. F. E. L. Beal's report on the food of American woodpeckers, published as Bulletin No. 37 of the biological division of the U.S. Department of Agriculture. The report is based on the examination of the contents of a large number of stomachs of sixteen species of these birds; but since the number of specimens examined was much smaller in some cases than in others, it is quite probable that some modification of the order in which these species are tabulated according to the nature of their food may be necessary in the future. Another element of uncertainty in this respect is due to the rapidity with which the vegetable food of the cambium-eating species passes through the stomach.

As the forests of the United States, like those of other countries, have a host of insect enemies, among which wood-boring beetles are pre-eminent, any natural agency that will assist in keeping these pests in check is of the highest value. In the case of wood-boring beetles, woodpeckers occupy the first place as destroyers, and among these the two species of the three-toed genus Picoides are the most valuable. In the typical *P. americanus* no less than 94·06 per cent. of the food consists of animal matter; while as regards its insect-food, 71·05 per cent. consists of beetles and the remainder of ants. Most of these beetles are wood-borers, although a percentage consists of harmless species. Ants also are deleterious to trees, since they often take possession of the borings from which beetles have been extracted by woodpeckers, until they in turn are routed out by these birds. Woodpeckers are frequently charged with inflicting damage on sound trees; but the charge, except in the case of the American group of sapsuckers, is considered to be unfounded. As regards sapsuckers, which feed on cambium, these certainly do inflict damage, which in some cases may be serious although, on the other hand, they consume legions of ants.

The colouring of the Jack snipe forms, according to Mr. F. J. Stubbs in *The Zoologist* for July, an absolutely perfect protective adaptation. In some localities the only means by which the bird can be detected when squatting in its proper haunts is by looking for a couple of curved blades of faded grass of a brighter hue than any indi-